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PHYTOPATHOLOGY

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SEPTEMBER, 1924

THE VIABILITY OF UREDOSPORES

W. E. Maneval

Many observations and tests have been made on the longevity of uredospores of rusts. The spores have been kept under various conditions, both in the open and indoors. Conclusions as to overwintering out of doors are sometimes doubtful, since mycelium may live through the winter and spores present in the spring may have developed during the winter or early spring. Freeman and Johnson (2) after reviewing the literature regarding overwintering of uredospores out of doors pointed out that previous conclusions were frequently based on opinion rather than on accurate observations. They obtained viable uredospores of *Puccinia graminis* throughout the winter from living hosts in the open, and as late as March 20 from plants buried in the snow from December 10 to that date. Likewise uredospores of *Puccinia rubigo-vera* and of *Puccinia simplex* buried in the snow germinated to March 20. It is probable that no development of spores occurred beneath the snow.

Various records, however, of tests with spores whose age was positively known show beyond doubt that uredospores of certain rusts may live a considerable time or through the winter either in the open or indoors.

Ward (9) succeeded in germinating uredospores of *Puccinia dispersa* (Erikss.) that had been kept dry in a tin box for 61 days. Fromme (3) reported a very low per cent (0.2) of germination in the case of uredospores of *Puccinia coronifera* that had been kept at room temperature for 84 days (Nov. 26–Feb. 18). He also gives records for various other rusts.

Reed and Holmes (6) tested uredospores of *Puccinia coronata* Cda. from volunteer oat plants that died December 1, and were left in the field through the winter. Twenty per cent of the spores germinated February 15, but only 5 per cent in a test marked "doubtful" March 1. However similar tests with spores from living plants in the open gave positive results to January 5, and negative results January 15. Increasing percentages of spores germinated from February 1 to April 1. The authors therefore supposed that the uredospores had died by January 15, but that mycelium remained alive and began producing new spores before February 1.

Melhus and Durrell (4) tested uredospores of *Puccinia coronata* Cda. after storing 55 days in dry capsules at 13° C. and secured twenty per cent of germination, but no germination if the spores were stored under similar conditions at either 6° C. or 20° C.

Peltier (5) found that the longevity of uredospores of *Puccinia graminis tritici*, Form III, depended on temperature and humidity. Spores stored at 25° C. and 49 per cent humidity germinated after 5 weeks but not after 6 weeks. At temperatures from 5°–15° C. with the humidity varying from 38–70 per cent the spores still germinate at the end of sixteen weeks.

Miss Fraizer (1) secured fair germination of uredospores of *Puccinia helianthi* which had been kept between sheets of blotting paper for 111 days (Nov. 20–March 10) at room temperature. Spores of the same rust collected September 10 and kept in an ice chest still germinated quite well (25 per cent) after 182 days.

Spaulding (7) reports that York, Overholts and Taylor found uredospores of *Cronartium ribicola* that had been dried in a plant press still viable after storage for 80 days in tight Mason jars kept in an ice chest. Besides uredospores in the open protected from rain germinated after 100 days; spores on leaves kept between sheets of glazed paper germinated after 169 days; and successful inoculations were secured with spores that had overwintered and were 270 days old. Miss Taylor (8) a year later also obtained successful infections with overwintered uredospores of this rust.

Various additional records might be cited indicating or proving that uredospores of various other rusts may live from two to six months, either in the open or when stored under more or less definite conditions of temperature and humidity. During the past two years the writer has tested the viability of uredospores of several species of rusts. The spores were collected at Columbia, Missouri, generally late in the fall, and after drying were kept in a cool (5–15° C.) room most of the time. In all cases the spores were allowed to remain on the host. At intervals germination tests were made by floating the spores on distilled water in small preparation dishes and incubating at room temperature for one or two days. In the records that follow the percentage of germination is generally not expressed definitely, but the approximate amount of germination is indicated.

Uromyces striatus Schr. on Medicago sativa L.

Uredospores of this rust were collected November 11, 1922, and kept in a cool room. No tests were made until March 23, 1923, when a fairly large proportion of spores germinated. Subsequent tests on March 31, April 13 and 20, and May 7, gave positive results but no spores germinated in a final test June 9. Collections of uredospores of March 3 and April 2, 1923, failed to germinate. Uredospores were also collected October 9, 1923, and

kept at room temperature until November 14, after which they were stored in a cool room. A high percentage of spores germinated November 14. Subsequent tests resulted as follows: December 12, fairly high per cent of germination; January 4, 10–15 per cent; February 1, few spores; February 27, numerous spores; March 29, 1 ± per cent; April 17, negative. Spores of this rust therefore remained viable for at least 173 to 178 days after collection.

Infection experiment.—In the spring of 1923 ten alfalfa plants were dug up, transferred to the greenhouse and potted. No rust was found in the field where these plants grew during the seasons of 1922 nor 1923. Six plants were inoculated with spores collected November 11, 1922. After inoculation the plants were kept in moist chambers for a suitable length of time. The other four plants were used as checks. Since the percentage of viable spores was small and no pustules had appeared by May 7, four of the plants were reinoculated on this date. The checks all gave negative results while the results with the inoculated plants were as follows:

Inoculated	Uredo pustules
1. 4/24 and 5/7	6/13—1 leaf; 6/18—4 leaves
2. 4/20 and 5/7	Negative
3. 4/24 and 5/7	6/18—1 leaf
4. 4/18 and 5/7	6/18—1 leaf
5. 4/20	6/19—1 leaf
6. 4/18	Negative

It seems, therefore, that uredospores of *Uromyces striatus* may not only retain their ability to germinate for nearly six months but also to infect alfalfa.

Puccinia sorghi Schw. on Zea Mays L.

Uredospores collected November 11, 1922, and stored in a cool room germinated to some extent when tested April 2, 1923. Spores collected November 6, 1923, on young (volunteer) corn plants killed by frost were kept in a cool room and tested at intervals of about a month. A very high percentage of spores germinated up to January 4. The results of later tests were as follows: February 1, rather low per cent; February 27, 10–15 per cent; March 29, 10 ± per cent; April 17, 1 — per cent. A third collection from nearly mature corn plants, October 2, 1923, was kept at room temperature until November 14, and after that in a cool room. When last tested, April 17, 1924, between 1 and 5 per cent of spores germinated. So in these tests uredospores remained viable at least 143 days after collection in 1922 and 168 to 180 days the next year.

Puccinia coronata Cda. on Avena sativa L.

Uredospores of this rust were collected October 18 and November 2, 1923. Both collections were kept at room temperature until November 6, and after that date in a cool room. Tests at approximately monthly intervals gave positive results to March 29, and negative results April 17. From 1–5 per cent of spores collected October 18, still germinated March 29, but only an occasional spore of the later collection. Some of these spores therefore continued to germinate for 149 to 164 days after collection.

Puccinia menthae Pers. var Americana Burr. on Monarda fistulosa L.

Uredospores collected October 9, 1923, were kept at room temperature till November 14, and later in a cool room. In tests similar to those above some spores continued to germinate until March 29, but none at the next test on April 17. Hence some of these spores retained their ability to germinate at least 173 days after collection.

Uromyces caryophyllinus (Sch.) Wint. on Dianthus caryophyllus L.

Uredospores were collected on living carnations in the greenhouse November 17, 1923, and after drying were stored in a cool room. A very high percentage of spores germinated when tested November 17 and December 12, and fewer January 4 and February 1. However, 25 ± per cent still germinated February 27, from 1-5 per cent March 29, 10 ± per cent April 17, 1 ± per cent May 3 and 1 — per cent May 19. It is evident from these tests that some uredospores of this rust may remain viable at least 185 days.

Puccinia amorphae Curt. on Amorpha fruticosa L.

Uredospores collected October 8, 1923, were kept at room temperature until November 14, and after this date in a cool room. Positive results in germination tests were obtained to January 4, but none on February 1, or later. These spores therefore remained viable for at least 89 days after collection.

SUMMARY OF RESULTS REFERRED TO ON VIABILITY OF UREDOSPORES

Ward, *Puccinia dispersa* (Erikss.) 61 days.
Fromme, *Puccinia coronifera* 84 days.
Reed and Holmes, *Puccinia coronata* Cda. 77 (91?) days.
Melhus and Durrell, *Puccinia coronata* Cda. 55 days.
Peltier, *Puccinia graminis*, Form III 92 days.
Fraizer, *Puccinia helianthi* 182 days.
Spaulding, *Cronartium ribicola* 80; 100; 169; 270 days.

Taylor, *Cronartium ribicola* Overwintered.
Maneval, *Uromyces striatus* Schr. 173; 178 days.
Maneval, *Puccinia sorghi* Schw. 143; 168; 180 days.
Maneval, *Puccinia coronata* Cda. 149; 164 days.
Maneval, *Puccinia menthae* Pers. var. *americana* Burr. 173 days.
Maneval, *Uromyces caryophyllinus* (Sch.) Wint. 185 days.
Maneval, *Puccinia amorphae* Curt. 89 days.

These records for 10 species of rusts show that at least 7 of them may live approximately 6 months at rather cool temperatures and moderate humidity. Judging from the behavior of these it is probable that under certain conditions uredospores of many other species would retain their germinating power from 3 to 6 months, or even longer. It is very probable that such conditions sometimes exist in nature, and particularly in barns in stored hay, and so forth. Hence it is very likely that rusts such as those of corn, alfalfa and oats may overwinter in the uredo stage, be disseminated and become established in the spring.

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DEPARTMENT OF BOTANY,
UNIVERSITY OF MISSOURI

LONGEVITY OF CULTURES OF FUSARIA

W. E MANEVAL

In a recent number of SCIENCE Miss McCrea (5) points out that thoroughly reliable records concerning the longevity of spores of fungi are not very numerous. Miss McCrea germinated spores of *Aspergillus oryzae* which had been preserved, after drying in the air, at an ordinary temperature in a sealed tube for twenty-two years. *Rhizopus nigricans* also developed from the spore dust used in these tests and so it seems that viable spores of this fungus too were present in the sealed tube.

Various similar records, but generally for shorter times, may be found in the literature. For the smuts De Bary (1, p. 344) cites the record of Liebenberg, according to which spores of various species of Ustilago and Tilletia, kept as herbarium specimens, lived from 3½ to 8½ years. Other investigators of smuts have obtained similar results. Wehmer (6) kept pure cultures of 2 species of fungi in diffuse light at room temperature about 2½ years, the culture vessels being plugged with cotton. On transferring to a sterile sugar medium 7 species failed to develop, 8 grew at once, and 6 after several weeks. In the case of these 6 species growth was obtained only after pouring a sterile medium into the original cultures. The fungi tested were mainly Phycomycetes and species of Aspergillus. Lafar (4, p. 201) cites earlier records of Wehmer for *Aspergillus wentii* (1 + year), *A. niger* (3 ± years) and *A. oryzae* (4 + years). Lafar also refers to the work of Eidam, Hansen and Brefeld indicating that spores of *A. flavus*, *A. fumigatus* and *A. glaucus* may remain viable for 6, 10 and 16 years respectively. Hansen (2) kept perithecia of *Anixiopsis stercoraria* dry in paper folders from 1874 to 1895. Transfers of ascospores were then made to a wort-gelatine medium and in a few days a vigorous, practically pure vegetative growth of Anixiopsis developed. Kurzwelly (3) found that spores of *Phycomyces nitens* dried in air died in a comparatively short time but if dried in a dessicator and stored in absolute alcohol still germinated after 2 years and 2 months.

In the spring of 1916 the writer placed stock cultures of species of Fusarium labeled as follows in an ice chest:

(1) *Fusarium conglutinans*
(2) *Fusarium niveum*
(3) *Fusarium oxysporum* Schlecht.
(4) *Fusarium vasinfectum* Atk.
(5) *Fusarium discolor* App. and Wollen.
(6) *Fusarium gibbosum*

(7) *Fusarium coeruleum* (Lb.) Sacc.
(8) *Fusarium solani* (Mart.) Sacc.
(9) *Fusarium trichothecioides* Wr.
(10) *Fusarium discolor* var. *sulphureum* (Schlecht.) App. and Wollenw.

The test tubes containing the cultures were plugged with cotton and the fungi were growing on stems, except *Fusarium discolor* and *Fusarium discolor* var. *sulphureum* which were on agar. All of the cultures were obtained by Dr. George M. Reed in the spring of 1916. The culture of *F. conglutinans* was received from the University of Wisconsin, and had been isolated from diseased cabbage January 14, 1913. The culture of *F. niveum* was obtained from C. W. Carpenter of the U. S. Department of Agriculture. The writer does not know the exact source of the other eight species, but it seems that they were all obtained from the same source, very probably from the U. S. Department of Agriculture. All apparently were authentic cultures.

Duplicate transfers from these cultures were made to potato dextrose (2 per cent) agar March 6, 1924, and allowed to incubate at room temperature. By March 10 growth in both tubes of *F. oxysporum* and of *F. conglutinans* was evident and in one tube of *F. vasinfectum*. On this date the entire piece of stem in the case of *F. gibbosum* was transferred and to the other tubes in which there was no growth a second transfer of spores and mycelium was made. On March 15 growth was evident in the second tube of *F. vasinfectum* and in the tube of *F. gibbosum* containing the piece of stem. Two or three days later pieces of agar or else stems were transferred in the case of the 6 species that had not grown. Positive results were obtained from these transfers by March 24, with *F. niveum, F. discolor, F. trichothecioides* and *F. solani*, but the other 2 species (*F. coeruleum* and *F. discolor* var. *sulphureum*) never grew. So after being preserved for approximately 8 years at a temperature near 10° C., most of the time, in test tubes plugged with cotton and in a rather moist atmosphere eight out of the ten species of Fusaria tested grew more or less readily.

One of the recommendations for control of diseases caused by species of Fusarium is a rotation of 5 to 8 years, based on the fact that a particular species of the fungus, if once established in the soil, would persist for several years. In such cases however it is probable that new growth occurs to some extent every year. In the stored cultures used in these tests it is likely that no new growth occurred after the first few weeks of storage in the ice chest and so the evidence is practically conclusive that either spores or mycelium or both remained viable for between 7 and 8 years.

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DEPARTMENT OF BOTANY,
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THE USE OF SULPHUR AS A FUNGICIDE AND FERTILIZER FOR SWEET POTATOES

J. F. Adams

With Four Figures in the Text

Experimental work with inoculated sulphur during the growing seasons of 1922 and 1923 has established evidence of its importance as a fungicide and fertilizer for sweet potatoes under Delaware conditions. Scurf, pox and black rot diseases have been reduced in prevalence and increased yields and improved keeping qualities of sweet potatoes have been experienced where the inoculated sulphur was used.

During 1922, four experiments were established to determine the effectiveness of inoculated sulphur for the control of scurf (*Monilochaetes infuscans* E. and H.) and pox (*Cytospora batatis* Elliott).[1] The experiments were established in cooperation with growers in Houston, Seaford, Laurel and Delmar, which are the principal centers of the commercial production of sweet potatoes in Delaware. One acre and half acre plots were used, and the soil was of the sassafras series. The results of the experiments for 1922 are summarized in table 1.

TABLE 1.—*Results with inoculated sulphur on yield of sweet potatoes and disease control during 1922*

Experiment	Fertilizer per Acre	Inoculated Sulphur per Acre	Soil Reaction at Harvest	Total Yield Primes, Seconds and Strings	Increase	Scurf	Pox
1	Lbs.	Lbs.	pH	Bu.	Bu.	%	%
Treated	1,200 of a 4–7–15	200 Broadcast	4.58	404.0	102.0	Trace	0
Check	"	.....	4.43	302.0	.....	6	0
2							
Treated	1,000 of a 2–8–10	400 Broadcast and drilled	3.90	296.3	98.8	Trace	40
Check	"		4.70	197.5	.....	15	95
3							
Treated	1,000 of a 5–7–5	400 Drilled	3.79	250.0	64.8	1	0
Check	"	.....	4.98	185.2	.....	35	0
4							
Treated	1,500 of a 2–8–10	300 Top Dressing	4.72	270.0	.....	10	0
Check	"		4.80	270.0	.....	30	0

[1] This disease has been generally reported as being caused by the slime mold described by Elliott as *Cytospora batatis*. This is not in agreement with the writer's findings who considers that the causal pathogene remains to be determined.

In experiment 1, the "Big Stem" variety of sweet potato was used and the plants set 18 x 32 inches. The inoculated sulphur was applied broadcast at the rate of 200 pounds per acre about three weeks before the sprouts were set. The total yield (primes, seconds and strings) is reported, which shows an increase of 102 bushels on the treated plot compared with the check plot. The total yield was computed by weight (one bushel weighing fifty-eight pounds) for one acre from the harvest of fifty hills in each plot. The tubers were nearly all of average prime size and a smaller percentage of strings than usual was found. The check plot showed 6 per cent prevalence of scurf as compared with only a trace in the treated plot.

The same variety of sweet potato was used in experiment No. 2 and the plants were set 18 x 42 inches. The inoculated sulphur was applied broadcast and also drilled in the row at the rate of 200 pounds per acre for each application. The field in which the experiment was located had been cropped continuously in sweet potatoes for over ten years. The prevalence of pox had been of increasing severity, and the crop in 1921 showed 100 per cent infection. Considering the past history of the sweet potato crops in this field, the yield in 1923 was very superior. The total yield was secured at harvest time in five-eighths baskets for each acre plot. The sulphur treated plot gave an increase of 98.8 bushel over the total yield of the check. The prevalence of 15 per cent scurf and 95 per cent pox in the check plot were reduced respectively in the sulphur treated plot to a trace and 40 per cent. The pox symptoms were most prevalent upon the larger fleshy roots and were of a shallow type, indicating that infection had become established during the latter part of the growing season. The sweet potatoes from the sulphur treated plot were much cleaner and much brighter in appearance.

A mixture of two varieties, "Gold Skins" and "Big Stems," was used in experiment No. 3, and the plants were set 20 x 36 inches. The total yield reported was secured at harvest time in five-eighths baskets from one-half acre for each plot. The control of scurf in the sulphur treated plot was very conspicuous being reduced to 1 per cent as compared with a 35 per cent prevalence in the check plot. As the result of contact of the roots with the sulphur, a reddish pigmentation of the fleshy roots was found in some hills. The nature and extent of this skin coloring was not of sufficient importance to interfere with their marketable value. The increase yield from the sulphur treated plot was 64.8 bushel over the total yield of the check plot.

The "Yellow Jersey" variety of sweet potato was used in experiment No. 4 and the plants were set 17 x 32 inches. The inoculated sulphur in this experiment was applied as a top dressing two weeks after the sprouts were planted. The total yield was not measured in this experiment, but it was estimated by the grower at 270 bushels and with no difference in yield on the two plots. The prevalence of scurf was reduced from 30 per cent in the

check to 10 per cent in the treated plot. Black rot was only slightly prevalent, and the examination of the harvested crop failed to show any noticeable differences in the amount of disease prevalence in the two plots.

The growing season of 1922 was very favorable for growth of sweet potatoes and yields above normal were generally reported by growers. Experimental results with inoculated sulphur during 1922 showed decided increases in yield, and a reduced prevalence of plant diseases. Soil samples were taken at harvest time and the soil reaction determined by the electrometric method and the hydrogen-ion concentration reported as the pH exponent.[1] These results are shown in table 1, and it was found that the soil acidity had been increased in each experiment except experiment No. 1. While consistent increased yields and plant disease control were secured, there was no definite correlation with the increased acidity. The increased yields show some evidence of the relation of yield to the amount of potash in the various complete fertilizers used. A more detailed analysis in this respect is hardly warranted with this preliminary work but will be taken up in the general discussion on the two years work.

The experimental work was continued during 1923 at Houston and Delmar. At Houston, two different experimental plots of one acre each were used. In the experimental plot for pox control the variation in the soil of the experimental field was such as to make it more practical to report the results as experiments No. 5 and No. 6 as given in table 2. The variety of sweet potato grown in the three experiments as reported in table 2 was the "Big Stem" and the plants were set 18 x 42 inches.

TABLE 2.—*Results of inoculated sulphur on yield of sweet potato and control of pox in 1923*

Experiment	Fertilizer per Acre	Inoculated Sulphur per Acre	Soil Reaction			Clean Crop	Slight Pox	Severe Pox Not Salable	Primes, Seconds and Strings Salable Total Yield
			May	Aug.	Oct.				
5	Lbs.	Lbs.	pH	pH	pH	Bu.	Bu.	Bu.	Bu.
Treated	1,000 of a 2–8–8	300 Broadcast	5.16	4.54	4.13	83.5	214.2	30.9	297.7
Check	"	.....	5.33	5.86	5.03	32.1	143.0	98.9	175.1
6	"	300	.....	.....	.....	176.6	266.6	3.3	443.2
Treated		Broadcast							
Check	"	.....	.....	.....	.....	113.4	166.6	60.0	280.0
7	"	200	.....	5.00	4.12	318.1	.....	.....	318.1
Treated		Broadcast							
Check	"	.....	.....	5.93	6.03	259.9	.....	.....	259.9

[1]The soil reactions were all determined by Professor Tarr, head of the Chemistry Department.

In experiment No. 5, the soil was of the sassafras loam type which has in previous years received frequent applications of manure. The soil contained a higher content of organic matter than the soil in any of the other experiments. Sweet potatoes harvested from this ground in 1922 showed heavy infection of pox. The yield reported in table 2 was computed from a

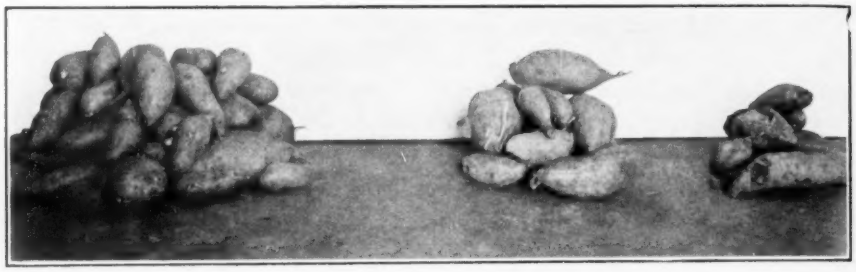

FIG. 1. Top. Results of keeping qualities of one bushel of sweet potatoes after two months in storage from sulphur-treated plot in Exp. No. 5. Clean sweet potatoes on left, Black Rot sweet potatoes in middle and Soft Rot sweet potatoes on right. See table IV.

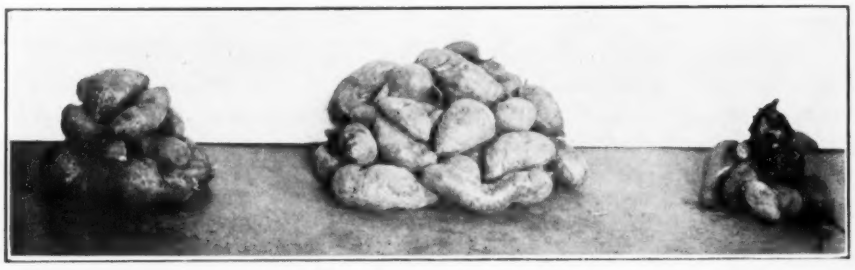

FIG. 2. Results of keeping qualities of one bushel of sweet potatoes after two months in storage from check plot in Exp. No. 6. Clean sweet potatoes on left, Black Rot sweet potatoes in middle and Soft Rot sweet potatoes on right. See table IV.

composite sample made up of twenty-eight hills each from two different rows. The evidence shows a material control of pox and an increased total yield as well as an increased commercial yield on the sulphur treated plot as compared with the check. There was an increase of 3.6 per cent of primes from the treated plot over the total of primes from the check. The sweet potatoes,from the treated area were much brighter in color and seemed more crisp in handling.

Experiment No. 6 was located on a soil of the light sassafras type but was similar to the preceding experiment in so far as the use of fertilizer and the variety of sweet potato used. The yield reported in table 2 was

computed from a composite sample made up of twenty hills each in two different rows of sweet potatoes. The actual commercial yield in primes showed a ten per cent increase for the sulphur treated plot. The amount of severe pox infection was much less than in the preceding experiment, where there was more organic material in the soil. The treated area com-

FIG. 3. Yield from twenty-eight hills of sweet potatoes in sulphur-treated plot of Exp. No. 5.

FIG. 4. Yield from twenty-eight hills of sweet potatoes in check plot of Exp. No. 5. The twenty-eight hills were consecutive and in parallel rows from each plot.

pared with the check showed an increase of 55.7 per cent of clean roots, 60.3 per cent of commerciable diseased roots and a decrease of 93.8 per cent for roots not commercial.

In experiment No. 7, the variety of sweet potato and fertilizer used were similar to the preceding experiment except that a reduction of 100 pounds per acre of inoculated sulphur was made. The total yield reported shows

a practical increase for the treated area but not as marked as in the two preceding experiments. There was practically no trace of scurf or evidence of black rot in either plot.

In experiment No. 6, the actual commercial yield showed a prevalence of 2.23 per cent of black rot for the treated area and 8.5 per cent for the check. At the time of harvest October 9, 1923, there was an apparent reduction of black rot on the sweet potatoes from the treated area. In the majority of the instances of heavy infection, black rot appeared to have become established through the lesions caused by the pox infection. At the time of harvest, the question was raised as to whether or not there was an actual control of black rot or an apparent reduction because of the better pox control. Further evidence in relation to the question of the control of black rot is indicated in the results secured on the keeping qualities of the sweet potatoes in storage. Round bushel baskets were used in which to store the potatoes and they were filled in the field by the grower in the same manner as the commercial harvest was made in the standard ⅝ baskets. The baskets were placed in the upper loft of a heated storage house and examination was made on December 10 at which time the data reported in table 4 was secured. The results as far as the control of soft rot was concerned were consistent. Soft rot may become established through careless handling at harvest and in storage. More extensive studies are essential before any definite conclusion may be drawn. Soft rot was more generally prevalent at harvest time during 1923 than during the previous three years. While the storage period was only of two months duration, the

TABLE 3.—*Results of inoculated sulphur on yield of sweet potatoes and control of scurf in 1923*

Experiment 8	Fertilizer per Acre	Inoculated Sulphur	Soil Reaction		Crop Primes Clean	Crop Primes with Scurf	Crop Seconds Clean	Crop Seconds Scurf	Total Commercial Yield	% Scurf
			June	Oct.						
Plot 1	5 tons Manure and 1,000 lbs. of a 3–7–5	Lbs. 150	pH 5.50	pH 5.50	Bu. 207.1	Bu. 52.80	Bu. 47.0	Bu. 5.4	Bu. 312.3	22.8
Plot 2 Received 400 lbs. of sulphur in 1922	"	.....	.....	5.20	91.5	91.5	91.5	10.9	285.4	55.9
Plot 3 Check	"	.....	5.81	5.64	135.5	65.1	66.9	5.3	272.8	34.7

results were sufficient to indicate that the sulphur treatment in the field had an influence on the keeping qualities and upon black rot development in storage. The evidence is presented as a preliminary report and the results are of such a promising nature that more extensive studies should be conducted.

The experiment established in Delmar during 1923 is outlined in table 3. A mixture of "Gold Skins" and "Big Stems" was used in experiment

TABLE 4.—*The relation of inoculated sulphur treatment for sweet potatoes on the development of black rot after sixty days' storage*

	From Treated Plot Basket 1			From Check Plot Basket 1		
	No. Potatoes	Lbs. Potatoes	% in Lbs.	No. Potatoes	Lbs. Potatoes	% in Lbs.
Sound	43	26.3	62.3	20	10.5	24.8
Black Rot	15	11.6	27.4	35	27.9	65.9
Soft Rot	9	4.5	10.6	9	3.9	9.2
Total	67	42.4	100.3	64	42.3	99.9
	Basket 2			Basket 2		
Sound	61	36.25	83.8	27	15.5	37.1
Black Rot	6	2.75	6.5	27	23.5	56.2
Soft Rot	6	4.25	9.8	5	2.75	6.6
Total	73	43.25	99.9	59	41.75	99.9

No. 8. Each plot consisted of one acre. The total commercial yield was computed at harvest time in five-eighths baskets from one quarter of each acre plot. All three plots received an application of manure and a complete fertilizer. It is of special interest to note that in contrast to the other experiments an organic fertilizer was applied in addition to the mineral fertilizer. Plot 2 is the same area as used in experiment No. 3 during 1922 and was included to determine the residual effect of the 1922 treatment. However in this instance, the evidence indicates that the organic fertilizer increased the buffer action and decreased the acidity of the soil. Commercial increased yields were secured from the plots receiving sulphur treatment, but the control of scurf was not as marked as in the other experiments. It is evident that the addition of organic material favored greater prevalence of the scurf, even on the sulphur treated plots. No doubt better control would have been secured if the application of sulphur had been doubled.

Before discussing the experimental work conducted during 1922 and 1923, it should prove interesting to review some of the previous work with sulphur as a fungicide and fertilizer for potatoes.

Halsted (3) used flowers of sulphur at the rate of 2500, 1250 and 625 pounds per acre. He found that "sulphur gives the highest yield of clean roots which were very smooth, and fair, free from scurf and all cracks and disfigurements." In 1898, Halsted (4) found that sulphur alone and in combination with lime and kainit demonstrated that the total crop yield for the sulphured plots was nearly three times as much as for the untreated plots, and the weight of clean roots was more than ten times as much. "The experiments for the past four years show clearly that the soil rot may be held in check by sulphur, and the fungicide retains its power for a long time in the soil. It is also seen that kainit has a beneficial action, and with sulphur good crops of comparatively clean roots may be produced upon land thoroughly filled with the germs of the soil rot. The experiments indicate that three to four hundred pounds of both the sulphur and the kainit may be used, and the best results are to be effected when the two substances are mixed thoroughly in that portion of the soil where the new roots are to form." The large amounts of sulphur as originally used by Halsted are not considered practical in view of the experimental results secured in Delaware. Three to four hundred pounds of sulphur per acre are considered the practical limits for the most favorable results.

Chester (1) used sulphur at the rate of 265 pounds to the acre by applying a tablespoonful to the hill as each plant was set. He concludes that sulphur applied in this way probably has some decided effect in diminishing the black rot.

Taubenhaus and Manns (10) found that when seed is infected with black rot, sulphur is of no value as a treatment. Sulphur is also ineffective in preventing soft rot in the seed bed. Thus a mere sprinkling of it is all that is necessary for an excess of sulphur in the soil interferes with the proper sprouting and growing of seed. The harmful effect of the excessive use of sulphur is apparently due to the prevention of the movement of water through the soil as well as to excessive acidity.

Poole (7) has reported upon some extensive experiments with the use of sulphur and inoculated sulphur for the control of scurf and pox. The studies on pox control showed that sulphur broadcasted at the rate of 200 and 400 pounds per acre decreased the per cent of infection and the slight control appeared to increase the yield. It was found that a higher per cent of nitrogen than is used on a normal sweet potato soil is advised for infected soils. Soil acidity is suggested as having some relation toward the reduction of disease. The scurf disease was reduced to a minimum by sulphur, and

inoculated sulphur. The scurf fungus was most virile under normal moisture conditions in the presence of an abundance of organic matter.

In summarizing the work with sulphur and inoculated sulphur, it has been found that consistent and practical control of scurf and pox was secured. However, in none of the work reported upon have the variable factors been sufficiently uniform to derive accurately any specific correlations. Some of the variable factors that appear definitely related with disease control are soil type, soil reaction, temperature, moisture, organic matter and to a certain extent mineral fertilizers.

It has been found that scurf and pox are more generally prevalent where the soil contains a high organic content. On comparing the control of these two diseases in experiments No. 5 and No. 8, it is found that the reduction of disease prevalence is much less on those soil types with higher organic content. Increasing the amount of sulphur applications on such soil types no doubt would increase the disease control. It is difficult to correlate definitely the results in control where different soil types were used. Nevertheless, the results reported on the work for 1922 and 1923 are such that sulphur can be used on variable soil types in Delaware for securing disease control that will prove practical for the grower of sweet potatoes.

Soil reaction studies appear to show some relation to the disease control and increase yields. With but one exception, it was found that as the pH exponent decreased and the hydrogen-ion concentration increased the prevalence of disease decreased. When the sulphur is applied to the soil, it is assumed to be transformed into sulphuric acid which is known to possess certain fungicidal properties. It is difficult to state with the results secured whether this end product of sulphur oxidation has proved directly toxic or has created conditions possibly through other products that have resulted in the inhibition of the soil pathogenes. In considering the acidity resulting from the sulphur applications, there is also a question whether the restraint of fungus growth is due to the total acidity or to the toxicity of the soil acids. The increased vigor of plant growth, as indicated by the increased yields on the sulphur plots, is possibly a factor in the reduction of disease prevalence but cannot be considered as the primary factor. It is obvious that with but one exception, experiment No. 1, that sulphur applications have increased the soil acidity and resulted in decreasing the disease prevalence and increasing the yields. In experiment No. 1, the decrease in acidity with the sulphur treatment may be associated with the higher buffer reaction of the soil. This appears to be well illustrated in experiment No. 8 on plots 1 and 2 where manure was applied along with the mineral fertilizer and sulphur.

The soil type will unquestionably influence the amount of change in soil reactions through sulphur applications which complicate correlations with

the soil acidity in the work reported. Joffe (5) states that some soils deficient in sulphur may also be deficient in buffering agents. Since sulphuric acid, which is formed from sulphur oxidized, has a high dissociation constant; and the latter is also a measure of the concentration of the hydrogen-ion, then a small amount of sulphuric acid or any other inorganic acid will impart to a soil poor in buffers a high concentration of hydrogen-ions. It is evident that soils of such a nature, even though entirely free from sulphur, will not respond to sulphur applications. Extreme variation is to be expected in the capacity of soils to neutralize, absorb and adsorb the acids formed. Shedd (9) found that sulphur oxidation in sand was slower than in soil, the more fertile the soil, the more rapid the oxidation. His results are in keeping with those reported by Joffe (5), that peat has a beneficial influence on the oxidation of the sulphur in alkali soils and manure comes next.

The disease control secured through sulphur applications along with the increase yields indicates that soils with the high hydrogen-ion concentration are favorable to the growth of the sweet potato plant. There is evidence that as the pH exponent decreases and the hydrogen-ion concentration increases the yield increases. The increased vigor of growth as indicated by the increase yields for the experimental work reported may possibly be a partial factor in the disease control. It is evident that the sweet potatoes will be productive under conditions of soil acidity that are not tolerated by certain other farm crops. The two years work with sulphur indicates that the sweet potato is an acid-tolerant plant. For this reason continued cropping of sweet potatoes on the same soil is more practical if proper sanitation for the plant diseases is maintained. The residual effect of the sulphur applications on many soils, poor in buffers, would require a correction of the soil reaction that may not prove practical in the rotation of certain crops.

The relation of temperature is a factor in disease prevalence as well as in growth and development of the host in relation to the sulphur applications. The sweet potato plant appears to be productive under higher temperature conditions and these same conditions along with average rainfall are favorable for the soil pathogenes. The influence of temperature upon the soil pathogenes is probably a factor for increased infection that may be cumulative and in direct relation to the development of the host.

The increased yields secured with sweet potatoes during the experimental work of 1922 and 1923 with the applications of inoculated sulphur is sufficiently consistent to consider this element, or mineral, as a fertilizer or plant food for sweet potatoes in Delaware. The experiments reported upon during 1922 further show evidence that there is a correlation with the amount of potash used, as the increased yields are in proportion to the

potash content of the complete fertilizers and amount applied. In addition to the fungicidal and plant food value of the inoculated sulphur, it is a factor in making available other plant food in the soil. Joffe (5) states that the sulphuric acid produced by the oxidation of sulphur may be utilized for the unlocking of potassium from the insoluble silicates. Schermerhorn (8) in summarizing results of fertilizer experiments with sweet potatoes found that as the nitrogen increases and the potash decreases, the yield of marketable tubers decreases. The reverse was found when the potash was increased up to 8 per cent and the nitrogen decreased to 2 or 3 per cent, as there was a decided increase in yields. The results also show that the phosphoric acid apparently played but a small part in the production of sweet potatoes.

It is of interest to mention in connection with the increased yields reported with inoculated sulphur that Johnson *et al* (6) secured marked increased yields of sweet potatoes with sodium chloride as a top dressing applied at the rate of 1000 pounds per acre. In comparing sodium and potassium salts, it was found that top dressings of potassium sulphate and potassium chloride containing 50 per cent potash and sodium sulphate and sodium chloride of 98 per cent purity as top dressing gave increased yields over the check plots. They had a beneficial effect upon production. The sodium equivalent treated plots taken as a whole showed no superiority in yield over the potassium equivalent plots.

The improved keeping qualities of sweet potatoes in storage as the result of sulphur applications to the soil is of fundamental and economic importance. Poole (7) has found that sweet potatoes from plots receiving high amounts of nitrogen did not keep as well as the potatoes which grew on the plots that received mixtures containing high phosphate and potash compounds. Where sulphur was used, there was less shrinkage than where it was not used. The storage rots were less in the potatoes stored from plots treated with sulphur. He considers that the superior keeping qualities noted in potatoes grown on soils where sulphur was used is no doubt due to the condition of potato skin. No proof is advanced in support of this statement and it would be of further interest to determine if any physiological changes may be a factor. Many growers in Delaware are of the opinion that the larger amounts of phosphate used improves the keeping qualities of sweet potatoes.

The general sandy soil types used for sweet potato production in Delaware have shown their receptiveness to sulphur applications for the favorable production of sweet potatoes. The increased soil acidity resulting from the sulphur applications has proven favorable for the growth of the sweet potato host. The increased soil acidity resulting in some instances from sulphur applications has been found to be unfavorable for optimum growth

of certain crops like white potatoes, rye, wheat and corn. It is interesting to consider that Eaton (2) found that most of the sulphur of soils is in organic form. He states, "there is a general correlation between the sulphur and organic matter content, soils of a high organic matter content having in general a high sulphur content. The surface soils are in general higher in sulphur than the subsoils." Judging from the results obtained and the work of other investigators, sulphur fertilization should prove quite generally beneficial on the Atlantic coast and Gulf coast.

SUMMARY

The use of inoculated sulphur[3] in Delaware has established evidence of its importance as a fungicide and fertilizer for sweet potatoes.

Consistent and practical control of scurf and pox have been secured and evidence that black rot is reduced in prevalence in the field as well as in development in storage on sweet potatoes where sulphur was used.

Consistent increased yields were secured where sulphur was used along with practical applications of a complete fertilizer.

Soil reaction studies appear to show some relation to the disease control and increased yields.

Results indicated that as the pH exponent decreased and the hydrogen-ion concentration increased the disease prevalence decreased.

There is evidence that as the pH exponent decreases and the hydrogen-ion concentration increases the yields increase.

It is considered as a result of the experimental work in Delaware that three hundred pounds of inoculated sulphur per acre is the maximum quantity essential for practical control and increase yields.

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5. JOFFE, J. S. Biochemical oxidation of sulphur and its significance to agriculture. New Jersey Agric. Exp. Sta. Bul. 374. *91 p.* 1922. Bibliography, p. 82–90.

[3] The inoculated sulphur used for this experimental work was secured from the Texas Gulf Sulphur Company.

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A LABORATORY PROJECTION APPARATUS

REGINALD H. COLLEY

WITH PLATES XXVI AND XXVII

The general principles of optical projection have been so well explained by the Gages[1] that any lengthy discussion of them in a short article on general utility apparatus is unnecessary. The apparatus described below was designed by the writer primarily for photomicrography, but it has found its greatest usefulness as a projection apparatus for the study of sections of infected plant tissue and for the measurement of large numbers of fungus spores. The fact that it has served both purposes so well is the excuse for explaining its construction in detail. The methods of construction involve no essentially new principles; but the combination of old principles and tools has been worked up into a very useful piece of laboratory machinery.

The support for the optical bed is a roomy cabinet six feet long by two feet deep by three feet one inch high, with drawers and closets fitted to hold all the elements of the apparatus and any other supplementary equipment (Plate XXVI, figs. A and B). The cabinet is mounted on ball bearing casters. On the top of the cabinet rests a three inch layer of mattress felt, and on top of that the main part of the optical bed, a slab of steatite, or soap-stone, measuring six feet two inches long by two feet two inches wide, and two inches thick. The mattress felt is naturally compressed by the weight of the stone slab. Bolted to the top of the slab—which was planed smooth and flat at the factory—are two steel rails ¾ of an inch square in cross section (Plate XXVII). The bolt holes in the slab are made large enough to allow for some lateral adjustment of the rails. The rails are ordinarily held 10 inches apart and perfectly parallel. Their main purpose is to keep the projection apparatus in proper optical alignment.

The elements of the projection apparatus are a fixed rheostat, an arc lamp, a pair of condensing lenses and a slight shield, a water cell, and a microscope fitted with a right angle prism reflector. All of the elements are mounted on wooden blocks (Plate II). The blocks are built up, or constructed from thin pieces glued together, rather than cut from one single piece of wood, and so made that the end grain of the wood rests against the rails. This arrangement almost entirely avoids the jamming and sticking which would be inevitable as a result of swelling on damp days if the blocks were placed so that tangential or radial surfaces pressed against the steel.

[1] Optical Projection. Gage, Simon Henry, and Henry Phelps Gage. *731 p., 413 fig.*, Comstock Publishing Company, Ithaca, N. Y. 1914.

Adjustment to the correct optical axis is preferably made with the wooden base blocks against *one* rail, because in very dry weather the blocks sometimes fit a little loosely between the rails. Fine adjustment is then accomplished by centering the arc and the condensing lenses and spacing them so that the beam of light passes through the water cell and just about fills the bottom lense of the substage condenser of the microscope.

The substage condenser is of the centering achromatic type, easily adjustable for distance from the slide and to the correct optical exis. The microscope objectives are apochromatic, and they give better images with the arc as a source of illumination than the less fully corrected achromatic lenses. Compensating oculars are always used. The microscope is fitted with a mechanical stage.

In practice the apparatus is set up so that the microscope projects over the end of the steatite slab, as shown in Plate XXVI, figure A. The light is directed downward—by means of the right angle prism reflector—on an adjustable shelf table (Plate XXVI, fig. A). The table is then moved up or down until the image of a 10 micron division on a micrometer slide becomes 10 millimeters long on the table. The size of the image is determined by measuring with a standard white faced millimeter scale. The top of the table is covered with a sheet of white paper on which is drawn a four inch circle representing the central area of the illumined projected field. Distortion within this central area is at a minimum. Sizes in millimeters on the millimeter scale can be read directly as the sizes in microns of the objects.

The lenses ordinarily employed for study and spore measurement work are the 4 mm. objective, fitted with a collar for making the correction for cover glass thickness, and a number six compensating ocular. The observer can, of course, use the power best suited to the problem at hand. With the room properly darkened no difficulty has been experienced in the projection or study of images at a magnification of 2,500.

The observer who is skilled in making slides and in the technique of the microscope can do most satisfactory work with projection apparatus of the type described. There are certain mechanical difficulties in its use, but they are easily overcome with a little practice. It is obvious that water mounts cannot be handled on the horizontal microscope. Spores, or tissue which is not finished in balsam for example, should be mounted in some semi-solid medium which will not run at low heat. The glycerine and glycerine jelly combination described in an earlier paper[1] has proven very satisfactory. In no case, with this or any other medium, should the slide

[1] Colley, Reginald H. A Biometric Comparison of the Urediniospores of *Cronartium ribicola* and *Cronartium occidentale*. Journal of Agricultural Research.—In press.

become overheated as a result of being left too long in the path of the direct light of the arc.

The ideal way to use the equipment is with the help of an assistant who runs the arc, adjusts the substage condenser, places the slides in the mechanical stage, and takes down records, while the observer sits on a low chair and confines himself strictly to focusing and observing. His eyes are adjusted to the lights and shades of the image under such conditions, whereas, if he works alone they are continually thrown out of adjustment by the intense light of the burning carbons. Working alone, however, is simply a matter of getting accustomed to the necessary manipulations.

Much actual labor would be eliminated if a suitable incandescent lamp could be found to take the place of the arc. So far none of them have proven satisfactory for magnifications as high as 1,000. An accurate clock feed arc would probably be easier to handle than the hand feed arc but even with the clock feed some adjustment would occasionally be necessary to keep the light in the correct optical axis.

For photomicrography the elements of the projecting equipment are pushed to one end of the optical bed to leave room for the camera, also mounted on a wooden block, and the whole apparatus is set up as in Plate XXVI, figure B.

The felt and steatite slab arrangement is copied directly from apparatus in the offices of Dr. K. F. Kellerman and Dr. N. A. Cobb, of the Bureau of Plant Industry. No record has been found of the previous use of the simple combination of wooden blocks and square rails on the optical bed.

The whole apparatus is so heavy that minor shocks do not disturb a given set up at all. For that matter even the heavy vibrations caused by passing street cars were in most cases absorbed by the felt, so the equipment is sufficiently steady for all practical purposes. Additional light shields to keep light that escapes from the arc housing from striking the eyes of the observer, or from illumining the room too much, and such additional equipment as focusing rods can be easily added to the apparatus if desired.

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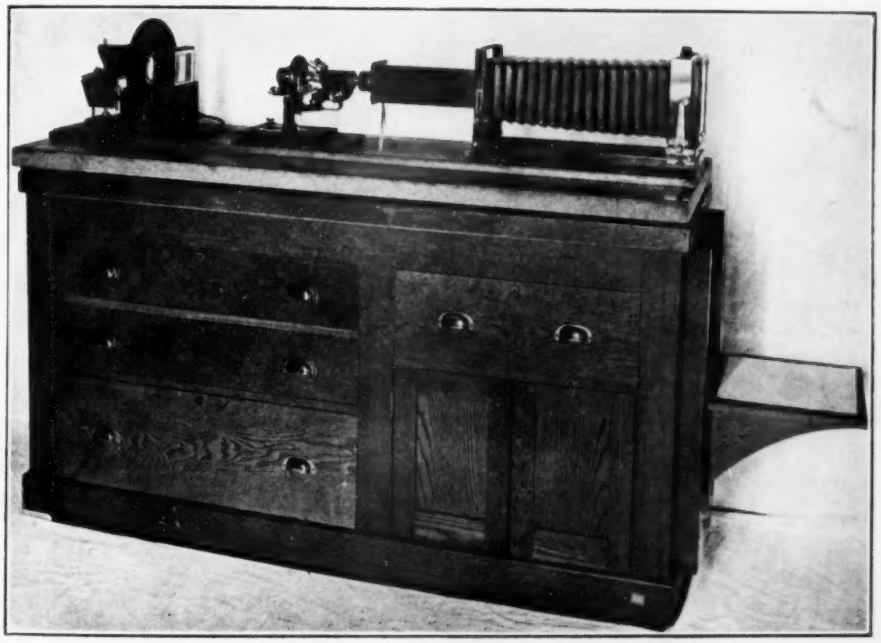
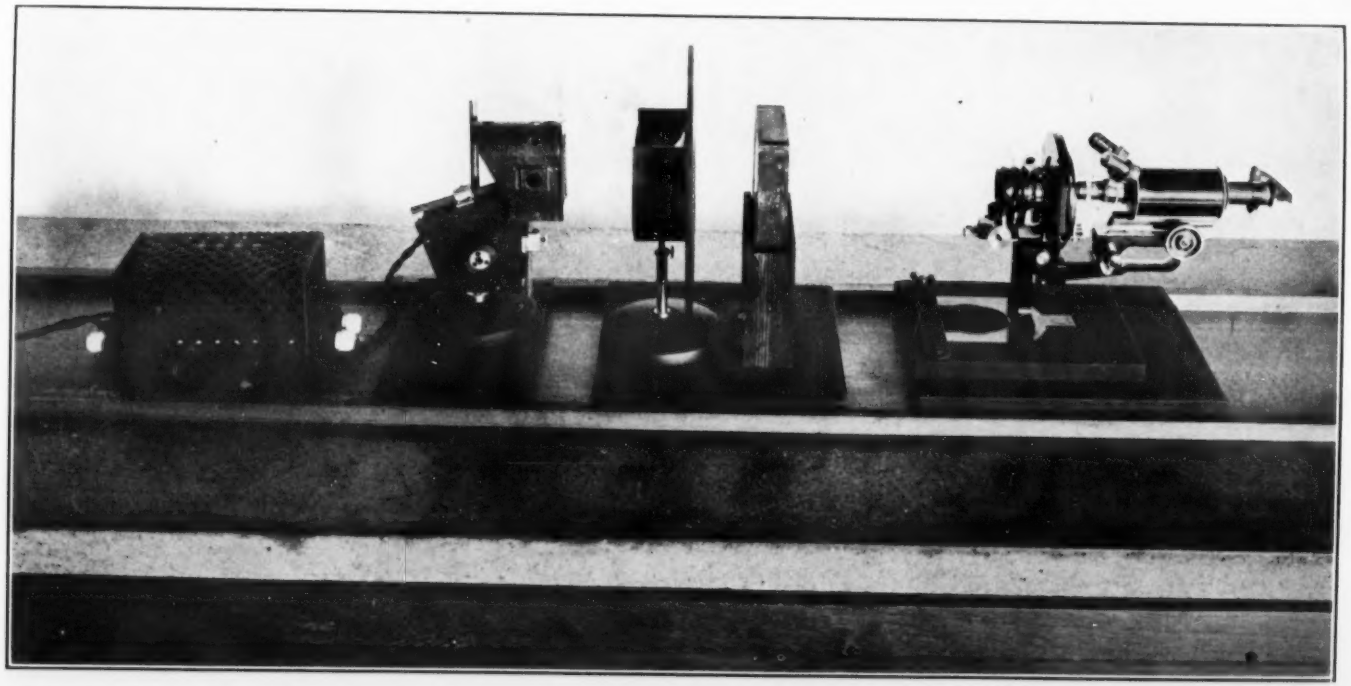


Fig. A (Upper). The a aratus set up for projection. The image is thrown upon the white paper on the adjustable shelf table. Fig. B (Lower). The apparatus set up for photomicrography.



The elements of the projection apparatus. From left to right: fixed rheostat, arc, condensing lenses with disk light shield, water cell, and microscope fitted with right angle prism reflector. The elements are held in the proper optical axis by the two steel rails bolted to the heavy steatite slab. Note the method of mounting the arc, the condensing lenses, and the microscope on the wooden blocks.

THE MANNER OF INFECTION OF PEACH TWIGS BY THE BROWN ROT FUNGUS

G. W. Fant[1]

In the summer of 1922 there appeared in sections of New Jersey a blighting of peach twigs which caused considerable concern among peach growers. Some orchardists were inclined to attribute the condition to toxic spray materials, while it appeared possible to the writer and others that the brown rot fungus, *Sclerotinia cinerea*, might be responsible. While no endeavor was made by the writer to ascertain the cause for the twig blighting in the field, it was thought that a study of the conditions under which twig infection by the brown rot fungus takes place would be of value in determining the agencies responsible for various cankered areas often appearing on the younger growth in peach orchards. Previous to the appearance of the blighting in the field, inoculation experiments had been conducted by the writer to learn whether a wounded condition is essential for twig infection by the brown rot fungus. Other infection studies were made later in the season following the epidemic of twig blighting. It is the purpose of this paper to report the results obtained from these studies.

In these experiments the inoculation trials were made by applying an inoculum of brown rot conidia in sterile water to wounded and unwounded peach twigs. It has been shown by Jehle[2] that infection through wounds takes place readily on the limbs of the peach tree. Current year twigs and those of the previous season are relatively free from visible wounds so that widespread infection of young twigs, more especially those of the current year, is associated with the problem of whether or not the fungus has the ability to penetrate the unbroken epidermis.

In the infection studies, shoots of the current year and of the previous year's growth were employed. Two series of infection trials were undertaken—the first in early spring and the second in midsummer. In this manner it was possible to subject the current year twigs when first formed in the spring and when more mature in the summer to the inoculum of brown rot conidia.

In the first series, which was undertaken in April and May, moist chambers were used which consisted of inverted bell jars placed upon small platforms in which a small opening was left for inserting the twig to be

[1] Paper No. 183 of the journal series, New Jersey Agricultural Experiment Stations, Department of Plant Pathology.

[2] Jehle, R. A. The brown rot canker of the peach. Phytopathology 3: 105–110. 1913.

inoculated. Twigs were selected which were free from visible wounds. The inoculum was applied with an atomizer. The bell jars were lined with blotting paper moistened with sterile water. For a period of from three to five days following these inoculations, the atmosphere within the moist chambers was kept saturated by putting sterile water on the blotting paper. In this manner it was possible to maintain the original droplets laden with conidia upon the surface of the twigs for a period of several days. At the end of one week following inoculation, the moist chambers were removed and the twigs were observed at intervals throughout the remainder of the season. The series consisted of six infection trials and, with the exception of one twig accidentally wounded in setting up the moist chamber, none of these showed evidence of infection.

The second series, undertaken in midsummer, was conducted with hollow celluloid cylinders serving as moist chambers. In some instances, only the tips of new shoots were sprayed with inoculum and inserted, while in others the twigs extended entirely through the cylinders. Absorbent cotton moistened with sterile water was placed within the cylinder to maintain a high relative humidity, and the ends of the cylinder were plugged with cotton. Water was applied as often as necessary in order to maintain saturation. At the end of one week, the cylinders were removed. No twig blighting resulted from this series of inoculations.

In a number of instances twigs were collected several weeks following petal fall, which showed distinct brown rot cankers surrounding the base of the blossom pedicels. It has been shown by Jehle[1] and others that cankers may come about through blossom infection. This form of infection is of course confined to twigs one year old or older. When such twigs are placed in moist chambers, conidial pustules soon appear upon the surface of the lesions. This indicates that the lesions are caused by the brown rot fungus and that undoubtedly the blossom serves as a point of entry for the fungus. From our observations, it would seem further that infection first of the blossoms and then of the twigs is most common when the blossoms have been subjected to injury from freezing.

The development of cankers in the loci of wounds as reported by previous investigators has already been referred to. In the experiments of the writer, when twigs were injured and the inoculum was applied to the wounds, brown rot cankers developed in all cases. These cankers continue to enlarge for several months, though no data are at hand concerning the length of the period of activity of the fungus in cankers. Still another form of fungus entry is that brought about by the contact of the mummy with the branch,

[1] *Loc. cit.*, p. 108.

and this type of entry has been ascribed to fungous penetration through the fruit spur.[1]

From the experiments reported in the preceding, the conclusion is drawn that the unwounded peach twig whether newly formed or of the previous year's growth is apparently resistant to infections through the epidermis. When twig blighting occurs, it is largely confined to infections which enter through blighted blossoms, through attached mummies, or through various sorts of wounds which may appear upon the surface of the peach twig.

[1] Smith, Erwin F. Peach rot and peach blight. Jour. of Mycology **5**: 123–134. 1889.

THE TROPICAL PLANT RESEARCH FOUNDATION

PERLEY SPAULDING

The Tropical Plant Research Foundation was incorporated under the laws of the District of Columbia, on June 6, 1924. The incorporators were Dr. Robert A. Harper, Maj. Geo. P. Ahern, and Dr. Wm. A. Orton. At a meeting of the incorporators the following trustees were elected to take charge of the affairs of the Foundation:

Scientific men:	*Years to Serve*	
President, Dr. L. R. Jones	2	Head of the Department of Plant Pathology of the University of Wisconsin. Representative of American Phytopathological Society.
Vice-President, Dr. R. A. Harper	3	Head of the Department of Botany of Columbia University. Representative of National Research Council.
Prof. S. C. Prescott	2	Head of the Department of Biology and Public Health, Massachusetts Institute of Technology.
Dr. D. L. Van Dine	1	Professor of Entomological Extension, Pennsylvania State College. Representative of American Association of Economic Entomologists.
Dr. William Crocker	1	Director, Boyce Thompson Institute for Plant Research, Yonkers, N. Y.
Men representing business interests:		
Mr. V. M. Cutter	5	Vice-President in charge of Tropical Divisions, United Fruit Company.
Mr. H. C. Lakin	4	President, The Cuba Company, New York.
Maj. Geo. P. Ahern	3	A retired army officer. Formerly, for fourteen years, Chief Forester of the Philippine Islands.
Mr. J. T. Crawley	1	Formerly Director of the Cuban Agricultural Experiment Station and of the Experiment Station of the Porto Rico Sugar Planters' Association. Now retired.

The articles of incorporation provide that the term of the organization shall be perpetual.

The particular objects and business of the Foundation are to promote research for the advancement of knowledge of the plants and crops of the tropics; to conduct investigations in plant pathology, entomology, plant

breeding, botany and forestry, horticulture and agronomy, and to publish the results thereof; and to establish and maintain such temporary or permanent stations and laboratories as may be necessary for the accomplishment of these objects, under the restrictions and regulations established in its by-laws.

The affairs, funds and property of the Foundation shall be in the general charge of a Board of Trustees, the number of whose members for the first year shall be nine, who shall be chosen by the incorporators, and who shall elect their successors, as provided for in the By-laws.

The By-laws of the Foundation provide that the members of the Board of Trustees will serve for five-year terms and will be eligible for re-election. Four members of the Board shall be representative of business interests, and five members shall be scientific men. Of the latter, one member shall be selected by the Board from nominees of the National Research Council; one from the membership of the American Phtopathological Society, after consultation with its Advisory Board; and one from the membership of the American Association of Economic Entomologists, after consultation with its Committee on Policy. The remaining six will be selected by the Board of Trustees as vacancies occur.

The Board will elect annually from its own members, a President and Vice-President; an Executive Committee of three to direct the affairs of the Foundation subject to the action of the Board, between meetings of the Board; a Treasurer; a Secretary; a Scientific Director and General Manager who must be a trained scientific man of established reputation and administrative ability, and who will have full charge of the work of the Foundation subject to the control of the Board of Trustees in matters of major policy; and an Executive Assistant, who will be charged with the business details of the work, direct the clerical force and act for the Scientific Director and General Manager during his absence.

A regular annual meeting of the Board of Trustees shall be held in the District of Columbia on the last Monday in April.

The National Research Council, the American Phytopathological Society, and the American Association of Economic Entomologists maintain advisory committees to advise the Foundation on the scientific phases of its projects and the choice of its scientific staff. This relation will be purely advisory.

The work of the Foundation is established upon a project basis and each must be approved by the Board of Trustees. The project statement will include the objects to be attained, the location of the work, the method of procedure which it is proposed to follow in the investigation, the leadership, relation to other agencies, cooperation if any, probable annual cost and source of support, and the estimated duration of the investigation.

Projects may be supported by individuals, firms, corporations, or other organizations. The administrative direction and control of the work shall be vested wholly in the Board of Trustees. Projects may be undertaken for states or governments under contracts approved by the Board of Trustees. The results of the research of the Foundation shall be published in the form of special reports or in scientific journals. The right to publish the scientific results shall not be waived or surrendered in any case.

The handling of the funds is safeguarded by their transmission through the Treasurer of the National Academy of Sciences and National Research Council, under proper audit by a certified public accountant.

Under the above terms the Board of Trustees have elected as Scientific Director and General Manager, Dr. William A. Orton, now Pathologist in charge of the Office of Cotton, Truck, and Forage Crop Disease Investigations of the Bureau of Plant Industry, United States Department of Agriculture.

The central office of the Foundation is in Washington, D. C. Address in care of the National Research Council. The northern laboratory headquarters will be at the Thompson Institute, Yonkers, N. Y. The tropical research will be done at temporary field laboratories located where the problems demand.

PHYTOPATHOLOGICAL NOTES

Photographic method for measuring and recording morphological and physical characters of plants. This method was devised as a means of describing types of sugar beets, used for breeding purposes. With this method one records easily and quickly data for innumerable exact measurements and characters, which may be referred to in the future as occasion requires. One not only obtains information for immediate use, but also records unconsciously much data, which often proves valuable in future years. This method shows to just what degree any individual approaches one's standard type. The complete record is in the form represented in figure 1, except that the corners marked off by dotted lines may be printed white as space for recording notes. It is hoped that this method will reduce the necessity for endless descriptions of degrees and characters, which are not always accurate.

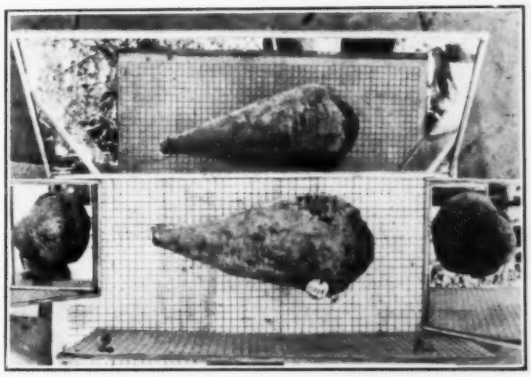


Fig. 1. Apparatus for photographing an object from four directions at one time.

The method consists in the photographing of beets against separate backgrounds of cross section paper. One centimeter cross section paper was used as a scale on these particular backgrounds although this could be varied to suit conditions. One background is placed horizontal and supports the beet directly below the camera lens, while the second background indicated by the number 2 in figure 1, is at a right angle to the first and is imaged in the large mirror at the opposite side of the apparatus. A mirror is then placed at each end of the horizontal background to give additional views. The mirrors are all held at different angles, depending upon the position of the camera lens. In our work we have placed the camera lens

exactly 120 centimeters from the horizontal background. This arrangement gives data for many measurements and four distinct views of the beet, with one exposure. The approximate angles of the mirrors and the supports for holding the beets in position are noted in figure 2.

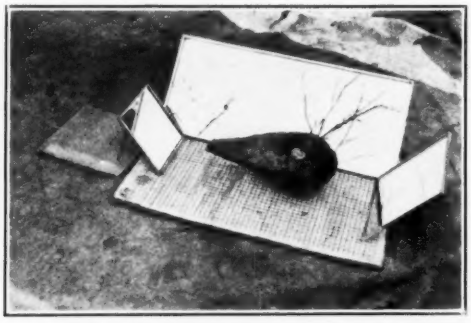


Fig. 2. Showing angle of inclination of mirrors.

After this apparatus is set up, beets can be photographed very quickly. This apparatus has been used at this station during the past three years, and has given favorable results. With the suggestion of Dr. E. W. Brandes, Pathologist in Charge, Sugar Plant Investigations, the apparatus has been permanently mounted upon a base, as shown in figure 3. When not in use it folds up, and may be readily carried about.

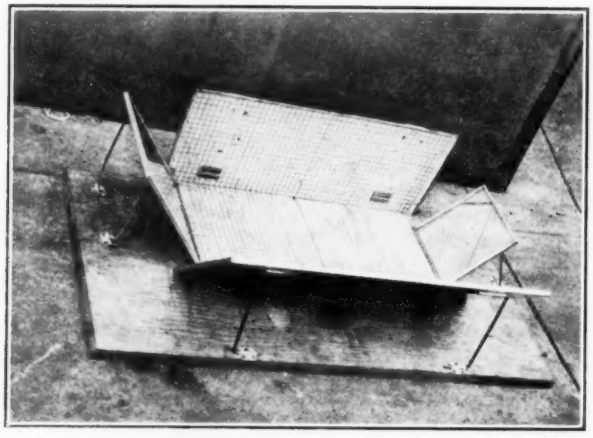


Fig. 3. Showing manner of fastening mirrors to base.

Since devising this apparatus the author finds that Havelock Ellis, in his book, The Criminal, 1915, illustrates a method of mirror photography.

Reference to this book shows that the position of the mirrors would prevent the use of scales and consequently no measurements could be made or recorded.—DEAN A. PACK.

Celery yellows.—Mr. Lowell F. Butler, who is working on celery yellows at the Colorado Agricultural College, reports the presence of two bacteria, one a short rod and the other a fusiform type, found in the brown internal lesions of the plants. He is now working to determine whether or not there may be a relation between the presence of these organisms and the occurrence of celery yellows.

Fusarium Conference, University of Wisconsin, Madison, Wis.—A general conference on the Fusarium problem held during June, July and part of August, at the University of Wisconsin, Madison, Wisconsin, has just come to a close. The conference developed out of studies carried on by the United Fruit Company on the wilt disease of bananas in Central America and was held in cooperation with the Bureau of Plant Industry, United States Department of Agriculture. Those present at the conference were Dr. H. W. Wollenweber, Pathologist, Biologische Reichsanstalt für Land und Forstwirtschaft, Germany, and Dr. O. A. Reinking, Pathologist, United Fruit Company, both representing the United Fruit Company; and Dr. C. D. Sherbakoff, Pathologist, Agricultural Experiment Station, University of Tennessee, Miss Helen Johann, Assistant Pathologist, Cereal Investigations, and Mrs. Alice Bailey, Junior Pathologist, Office of Cotton, Truck and Forage Crop Disease Investigations, representing the Bureau of Plant Industry, United States Department of Agriculture. The work of the conference covered, in so far as possible, the study, comparison and identification of specimens and cultures of fungi at present available. Because of the major part in the conference taken by the United Fruit Company, the main part of the studies were made on the tropical collection. The studies made of the entire collection embodied species from all sections of the sub-genus Fusarium, including important border-line strains, thereby making it possible to arrive at a uniform taxonomy of the group. It is believed that the principal points of difference have been agreed upon. A general paper presenting a clearer understanding of the Fusarium problem from the standpoint of the identification of species will be presented as a result of the studies. Pure cultures and dried specimens of each of the species studied and identified will be placed in the Office of Pathological Collections, Bureau of Plant Industry, United States Department of Agriculture.

Abstracts of papers for winter meeting.—November 1 is the time limit for the submission of abstracts of papers that are to be delivered at the

Washington Meeting. This is one month earlier than usual and members are asked to make special note of the change and to start preparation of their papers early. All abstracts will be reviewed and edited by an editorial committee and only those that embody definite results will be published. —R. J. HASKELL, *Secretary-Treasurer.*

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